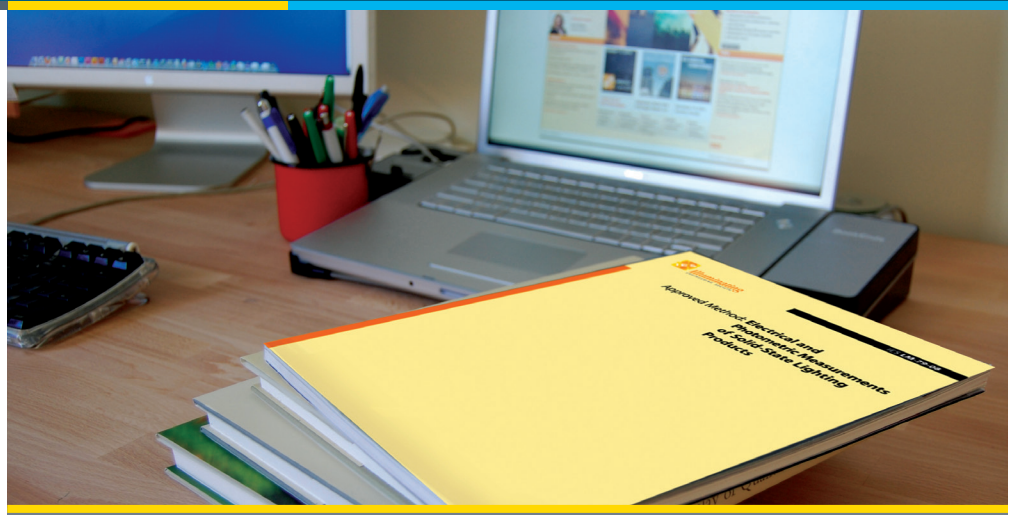
SOLID-STATE LIGHTING:

Standards Increase Market Confidence in SSL Performance

The U.S. Department of Energy supports industry in developing solid-state lighting (SSL) product standards, a vital foundation for market adoption and growth.



Industry organizations are setting standards that account for the unique attributes of SSL products, making it easier for buyers to select the best product for an application.
Photo courtesy of Akoya.

The use of national standards and test methods is critical to lighting design and bolsters consumer confidence in products. Like traditional lighting products, LED-based luminaires sold in the United States rely on industry-developed standards and test methods to characterize their performance and safety. However, the unique attributes of LEDs necessitate the development of new standards to effectively measure and characterize this technology.

Until recently, the lack of sufficient standards for SSL generated a great deal of confusion and frustration in the market. Variations in testing methods and terminology from one manufacturer to another made it difficult to compare new LED products to other light sources as well as to other LED products.

The U.S. Department of Energy has been working closely with a network of standards-setting organizations to accelerate the development and implementation of needed SSL standards. DOE provides standards development support to the process, which includes hosting ongoing workshops to foster coordination and collaboration on related efforts. These workshops are attended by representatives and committee members from the major standards groups: American National Standards Institute (ANSI), Illuminating Engineering Society of North America (IES), National Electrical Manufacturers Association (NEMA), National Institute of Standards and Technology (NIST), Underwriters Laboratories Inc. (UL), Commission Internationale de l'Eclairage (CIE), CSA International, International Electrotechnical Commission (IEC), and Institute of Electrical and Electronic Engineers (IEEE).

Current SSL Standards and White Papers

- **ANSI C78.377-2008, Specifications for the Chromaticity of Solid-State Lighting Products**, specifies recommended color ranges for white LEDs with various correlated color temperatures. Color range and color temperature are metrics of critical importance to lighting designers.[1]
- **IES G-2, Guideline for the Application of General Illumination ("White") Light-Emitting Diode (LED) Technologies**, provides lighting and design professionals with a general understanding of LED technology as it pertains to interior and exterior illumination, as well as useful design and application guidance for effective use of LEDs.[2]
- **IES LM-79-2008, Approved Method for the Electrical and Photometric Testing of Solid-State Lighting Devices**, enables the calculation of LED luminaire efficacy (net light output from the luminaire divided by the input power and measured in lumens per watt). Luminaire efficacy is the most reliable way to measure LED product performance, measuring

luminaire performance as a whole instead of relying on traditional methods that separate lamp ratings and fixture efficiency. LM-79 helps establish a foundation for accurate comparisons of luminaire performance, not only for SSL, but for all sources.

- **IES LM-80-2008, Approved Method for Measuring Lumen Depreciation of LED Light Sources**, supports an assessment of expected LED lifetime by defining a method of testing lamp depreciation. Unlike traditional filament-based sources, which usually fail completely, LEDs typically don't fail; they simply fade over time, which is referred to as lumen depreciation. LM-80 establishes a standard method for testing lumen depreciation.

- **IES LM-82-2012, Approved Method for the Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature**, provides a method for measuring the lumen degradation of light engine products at various temperatures in support of manufacturers determining LED luminaire reliability and lifetime characteristics.

- **IES RP-16 Addenda a and b, Nomenclature and Definitions for Illuminating Engineering**, provides industry-standard definitions for terminology related to SSL.

- **IES TM-21-2011, Projecting Long-Term Lumen Maintenance of LED Light Sources,** specifies a recommended method for projecting lumen maintenance of LED light sources based on LM-80 collected data.

- **NEMA LSD 45-2009, Recommendations for Solid-State Lighting Sub-Assembly Interfaces for Luminaires**, provides guidance on the design and construction of interconnects (sockets) for SSL applications.[3]

- **NEMA LSD 49-2010, Solid-State Lighting for Incandescent Replacement—Best Practices for Dimming**, provides recommendations for the application of dimming for screw-based incandescent replacement SSL products.

- **NEMA SSL 1-2010, Electronic Drivers for LED Devices, Arrays, or Systems**, provides specifications for and operating characteristics of non-integral electronic drivers (power supplies) intended for general lighting applications.

- **NEMA SSL 3-2011, High-Power White LED Binning for General Illumination**, provides a consistent format for categorizing (binning) color varieties of LEDs during their production and integration into lighting products.

- **NEMA SSL 4-2012, Retrofit Lamps: Minimum Performance Requirements**, provides performance criteria standards for integral LED lamps, including color, light output, operating voltage. lumen maintenance, size, and electrical characteristics.

- **NEMA SSL 6-2010, Solid State Lighting for Incandescent Replacement—Dimming**, provides dimming recommendations for retrofitting SSL products into systems that previously used incandescent screw-base lamps.

- **UL 8750, Safety Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products**, specifies the minimum safety requirements for SSL components, including LEDs and LED arrays, power supplies, and control circuitry.[4]

Standards in Development

- **CIE TC1-69, Color Quality Scale**
- **IES LM-XX1, Approved Method for the Measurements of High Power LEDs**
- **IES LM-XX4, Method for the Electrical and Photometric Measurements of Organic LED (OLED) Light Sources**
- **IES-TM-XX3, Method for Measuring Lumen Maintenance of LED Lamps, Light Engines, and Luminaires**
- **IES TM-XX5, Method for Estimating the Rated Life of an LED Product (incorporates lumen degradation and other failure modes)**

Over time, these and other standards will remove the guesswork about comparative product performance, making it easier for lighting manufacturers, designers, and specifiers to select the best product for an application. As industry experts continue the painstaking work of standards development, they are contributing to a growing body of information that will help support SSL innovation, as well as market adoption and growth.

For More Information

For more information on SSL standards, see ssl.energy.gov/standards.html.

1. The C78.377 standard is available for hard copy purchase or as a free download from NEMA at www.nema.org/stds/ANSI-ANSLG-C78-377.cfm#download. Hard copies can also be purchased from ANSI at www.webstore.ansi.org.
2. Electronic copies of G-2, LM-79, LM-80, LM-82, RP-16, and TM-21 may be purchased online through IES at www.ies.org/store.
3. LSD 45 and LSD 49 are available as free downloads from NEMA at www.nema.org/stds/lsd45.cfm#download and www.nema.org/stds/lsd49.cfm#download. SSL 1, SSL 3, SSL 4, and SSL 6 are available for purchase at www.nema.org/stds.
4. UL customers can obtain the outline for free (with login) at www.ulstandards.com or for purchase at www.comm-2000.com.

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DOE/EE-0722 • May 2012
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